

A photograph of a semiconductor fabrication plant (foundry) with workers in cleanroom suits, overlaid with a semi-transparent orange filter. The image shows a long, brightly lit corridor with workers in white cleanroom suits walking away from the camera. The ceiling is high with visible industrial infrastructure. The floor is polished and reflects the overhead lights. The overall tone is professional and technological.

# FOUNDRY-DRIVEN INNOVATION IN THE MOBILITY ERA

AJIT MANOCHA, CEO, GLOBALFOUNDRIES



GLOBALFOUNDRIES®

# First, a quick poll...

What is the biggest challenge facing our industry today?

A. Technology ( 141672 )

B. Talent ( 141689 )

C. Economic ( 141752 )

*Text your response to 22333 now*





# Agenda

The Impact of Mobile Era  
Technology Challenges

Economic Realities

Evolving the Business Model

Foundry 2.0<sup>SM</sup> at Work



# Agenda

The Impact of Mobile Era

Technology Challenges

Economic Realities

Evolving the Business Model

Foundry 2.0<sup>SM</sup> at Work

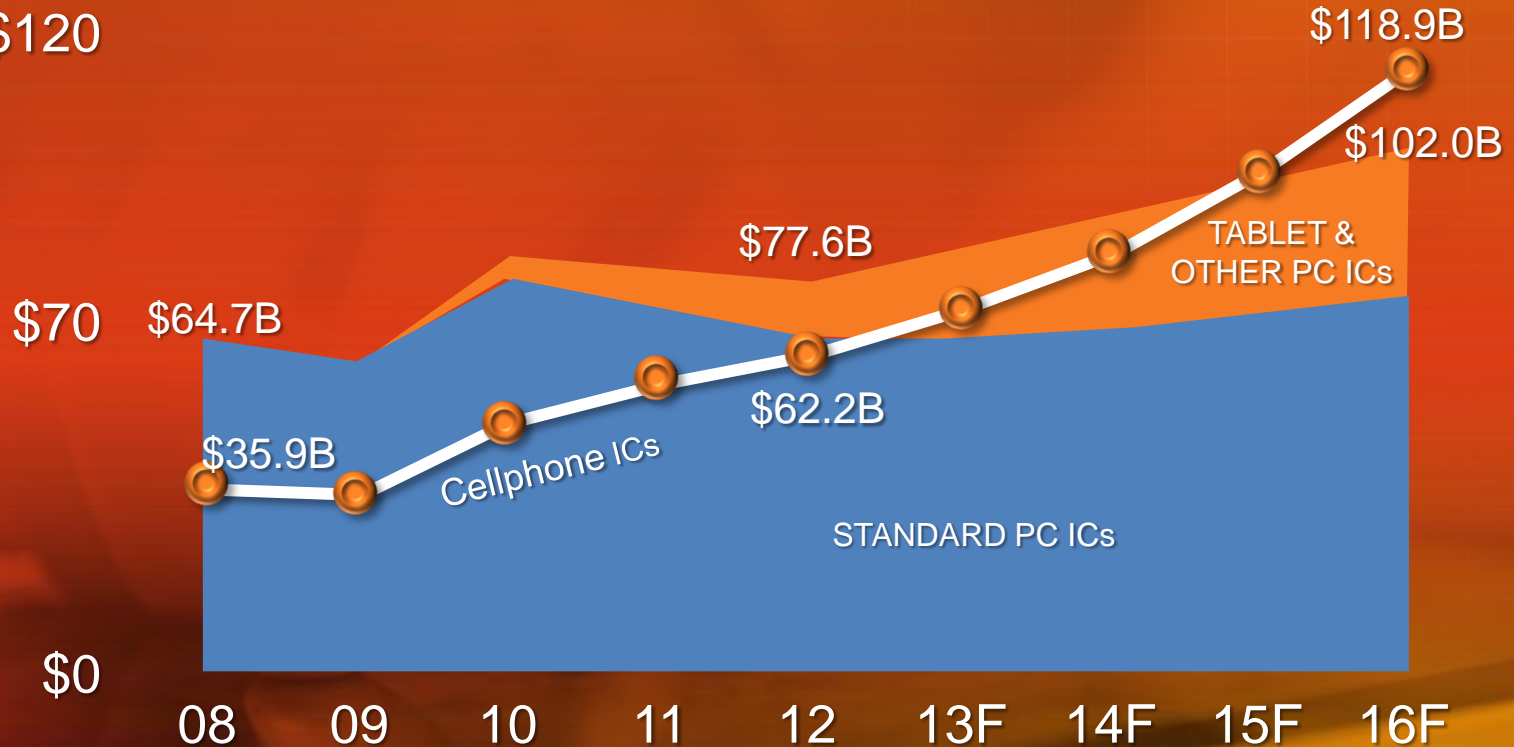




# The Mobile Impact on Silicon Consumption

PC and Cellphone  
IC Markets (\$B)

## IC Market for PCs vs. Cellphones



# Mobile Drives New Requirements: Power, Performance and Features



Higher data rates

## High resolution screens

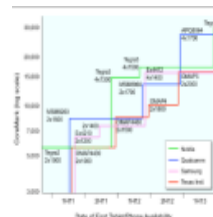
# Multicore processors

## Thinner form factors

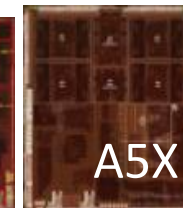
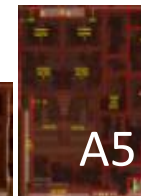
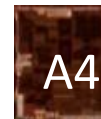
# Power



## Performance\*



## Area



# Mobile Device System-Level Integration Requirements Driving Advanced Technology

Devices	2011	2012	2013	2014	2015
Application Processor	45NM (Dual Core)	45NM (Dual / Quad Core)	28nm (Quad Core)	28nm (Quad Core)	<=20nm (Quad Core)
Baseband Processor					
WiFi	65nm	40NM (Dual Core)			
BT/FM					
GPS					
NFC Controller		65nm	40nm		
RF / Transceiver	40nm	40nm	28nm	28nm	
DRAM	<=20nm	19nm	15nm	13nm	10nm
NAND Flash	<=20nm	19nm	15nm	13nm	10nm
Audio / Video Codec	180nm	130nm	130nm	90nm	65nm
Power Management IC					
Noise Cancellation IC		180nm			
Touchscreen Controller	130nm	90nm	90nm		
Gesture Recognition			90nm	65nm	
e-Compass / e-Gyroscope	250nm	180nm	180nm	180nm	180nm
Total Devices	8	10	9	7	5

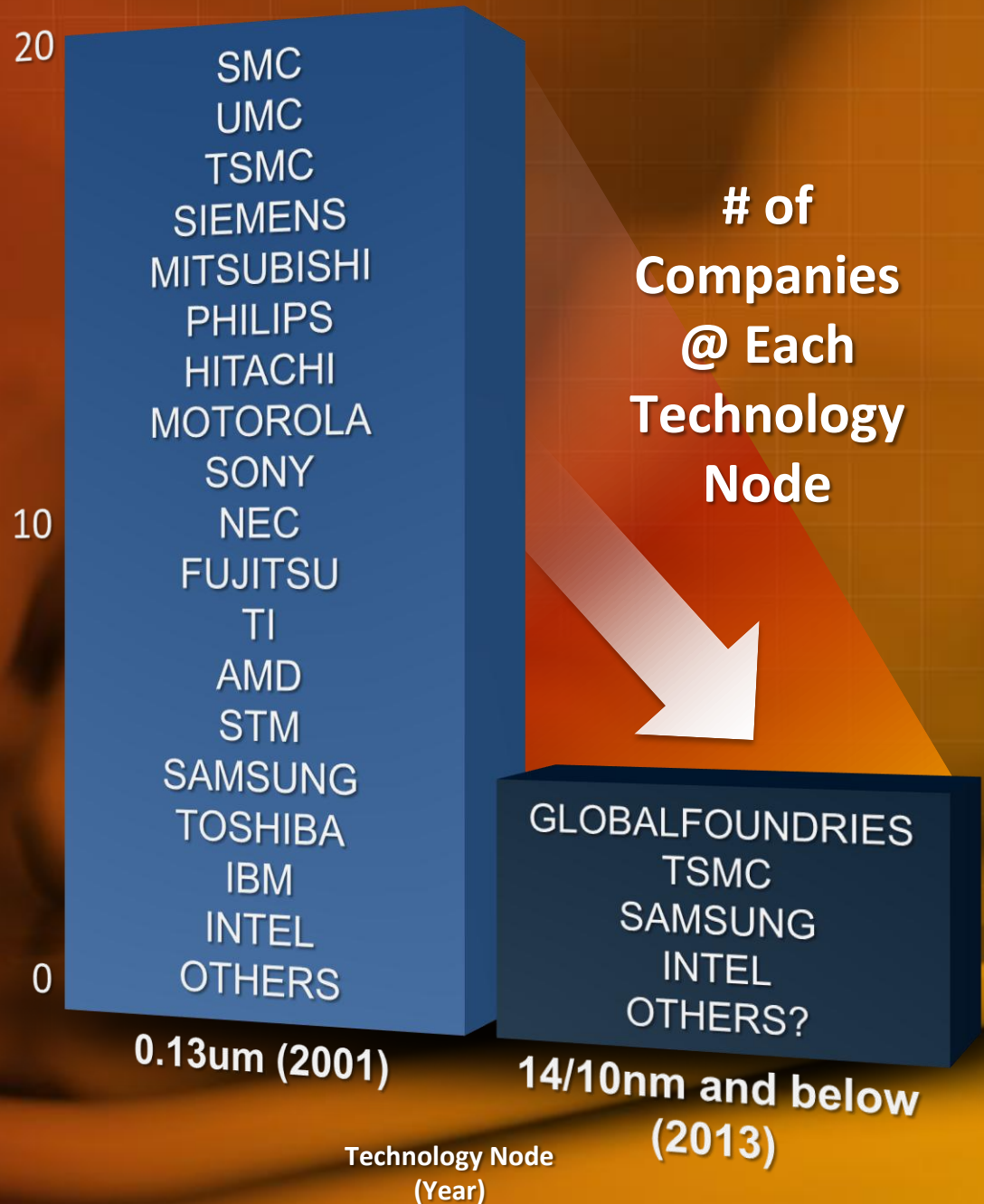




# Cost of Ownership Driving New Dynamics

(For high-volume  
manufacturers...>50K  
wpm)

SOURCE: Handel Jones, IBS Consulting



GLOBALFOUNDRIES®

# Agenda

The Impact of Mobile Era

Technology Challenges

Economic Realities

Evolving the Business Model

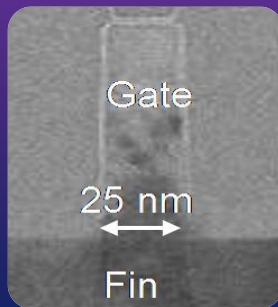
Foundry 2.0<sup>SM</sup> at Work



# The “Big Five” Challenges

## Device Architectures/ Materials

FDSOI  
FinFETs  
NanoWires  
III-V



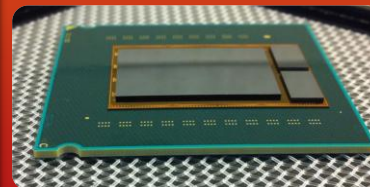
## Litho/EUV

Cost  
Multi-pattern  
immersion  
EUV Source power  
Tool  
availability



## Packaging

‘Normal economics’  
are dead  
Value proposition  
shifting toward PPC  
Alternative scaling  
opportunities  
(2.5/3D)



## 450mm

Pilot lines and  
HVM timing driven  
by 193i and EUV  
lithography  
G450C

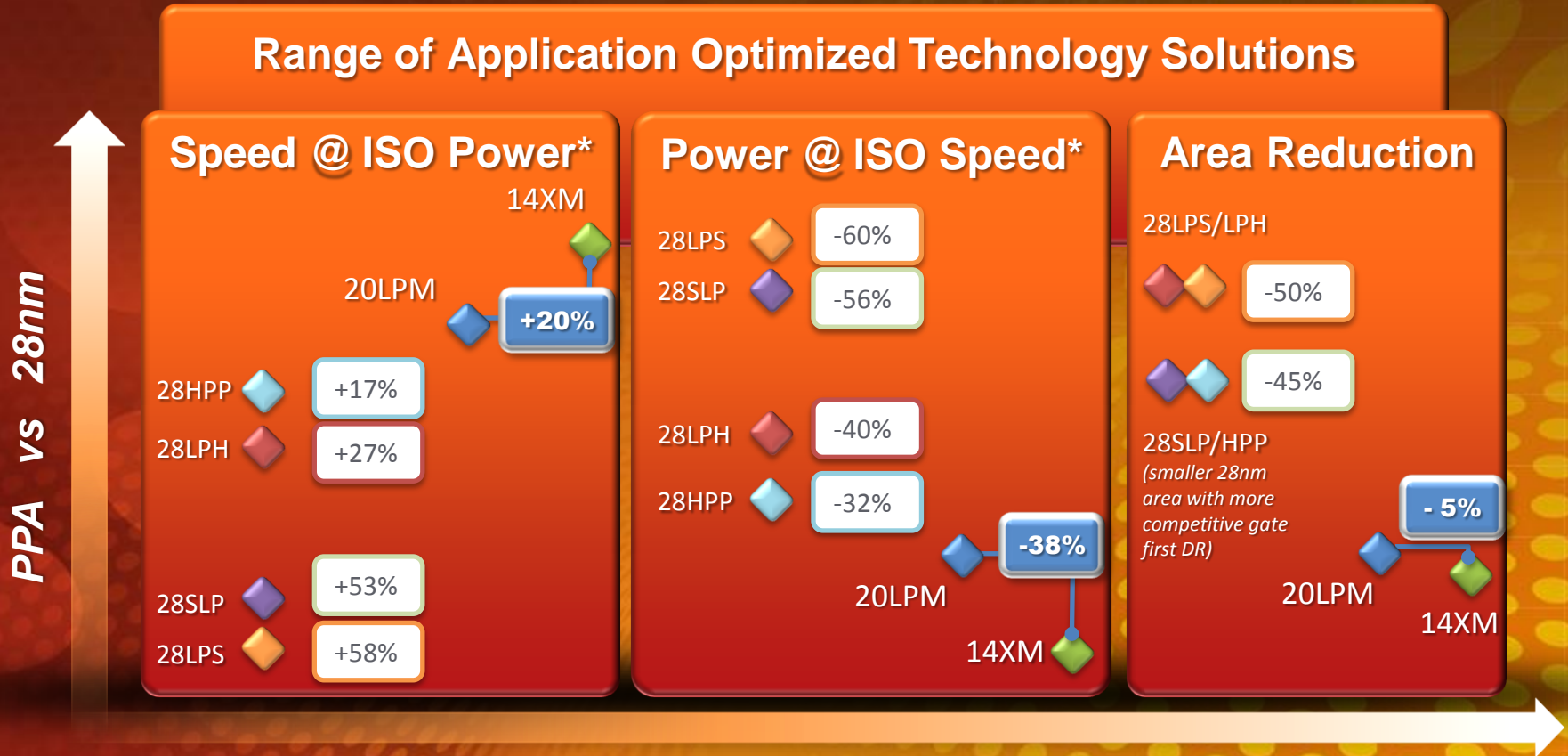


**COST – Time to Everything, Moore’s Law,  
SCM Security, Talent, IP Security**

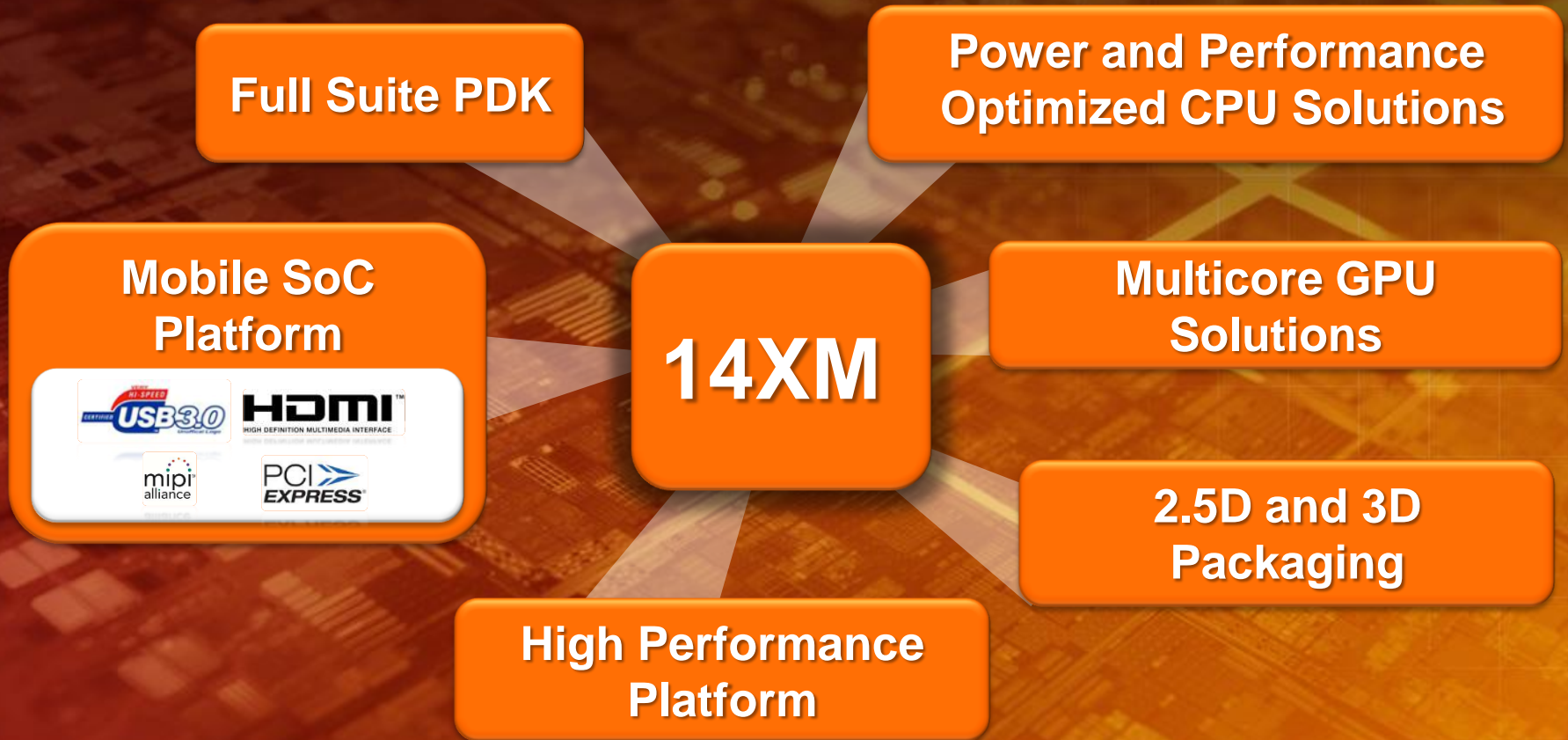




# 28nm-20nm-14nm: PPA Value Proposition



# 14XM FinFET – Total Solution



***“Other companies will follow GLOBALFOUNDRIES’ lead.  
I expect everyone to do it.”***

*Dr. Chemning Hu, Wall Street Journal interview*

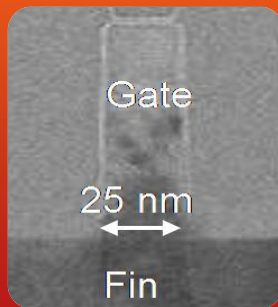


GLOBALFOUNDRIES®

# The “Big Five” Challenges

## Device Architectures/ Materials

FDSOI  
FinFETs  
NanoWires  
III-V



## Litho/EUV

Cost  
Multi-pattern  
immersion  
EUV Source power  
Tool  
availability



## Packaging

‘Normal economics’  
are dead  
Value proposition  
shifting toward PPC  
Alternative scaling  
opportunities  
(2.5/3D)



## 450mm

Pilot lines and  
HVM timing driven  
by 193i and EUV  
lithography  
G450C



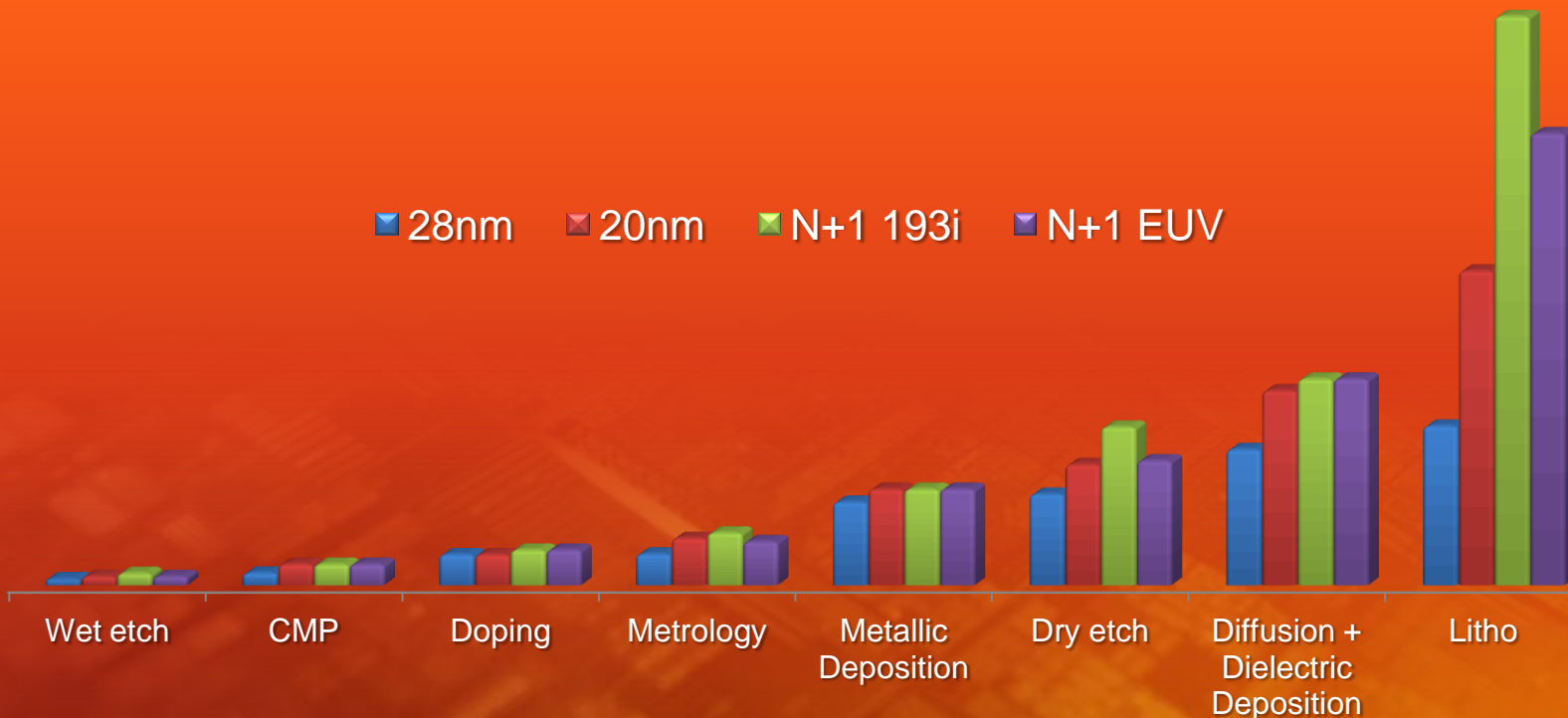
**Cost –Time to Everything, Moore’s Law,  
SCM Security, Talent, IP Security**

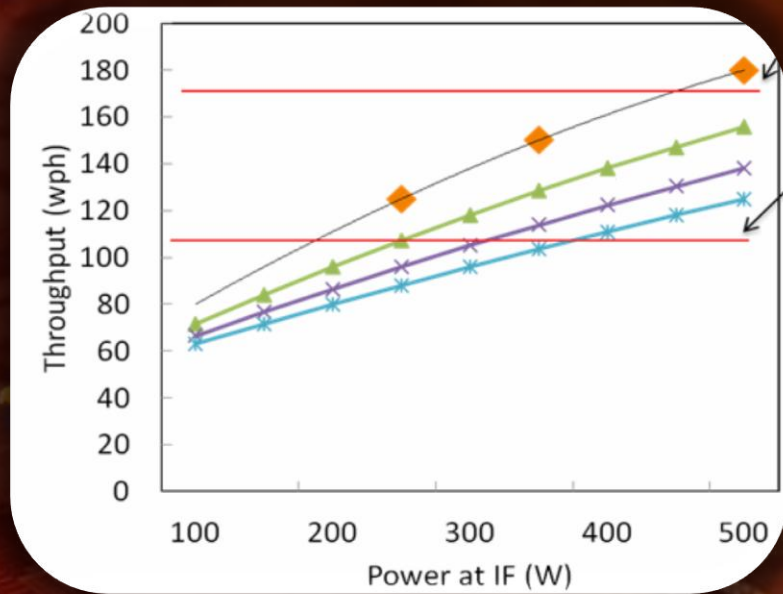




# Lithography Dominates the Cost Impact of Scaling

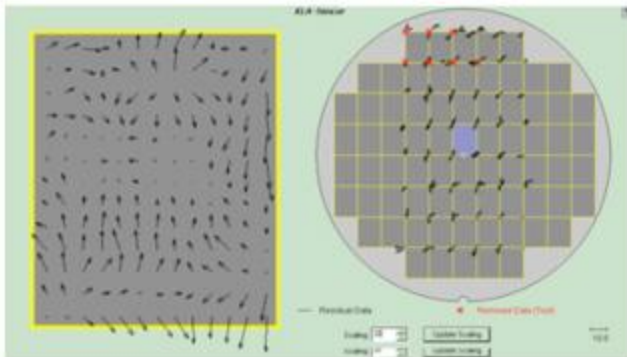
At advanced nodes, Litho starts to dominate the wafer cost.



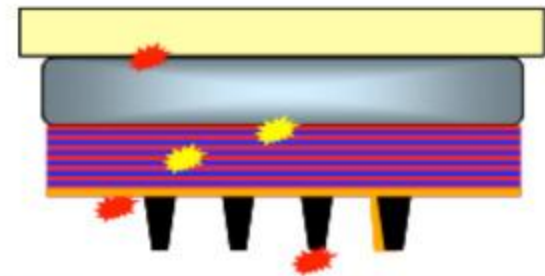


# Is EUV Ready for 10nm?

**Image Placement**



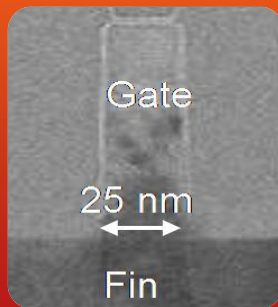
**Mask Defects**



# The “Big Five” Challenges

## Device Architectures/ Materials

FDSOI  
FinFETs  
NanoWires  
III-V



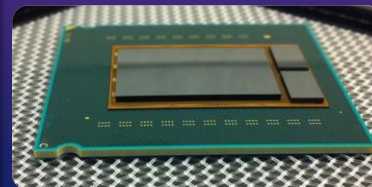
## Litho/EUV

Cost  
Multi-pattern  
immersion  
EUV Source power  
Tool  
availability



## Packaging

‘Normal economics’  
are dead  
Value proposition  
shifting toward PPC  
Alternative scaling  
opportunities  
(2.5/3D)



## 450mm

Pilot lines and  
HVM timing driven  
by 193i and EUV  
lithography  
G450C



**COST – Time to Everything, Moore’s Law,  
SCM Security, Talent, IP Security**

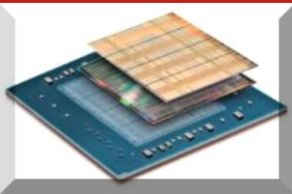




# Packaging Will Evolve to New Dimensions

**Silicon Partitioning with Interposers**

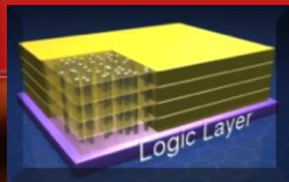
**Market:**  
FPGA



**2011**

**Memory Cube**

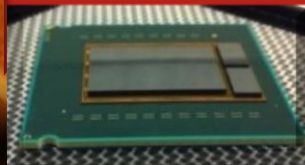
**Market:**  
Server and Computing



**2013**

**Logic + Memory on Interposer**

**Market:**  
GPU, CPU,  
Network Processors



**2013-14**

**Wide I/O Memory on Apps Processor**

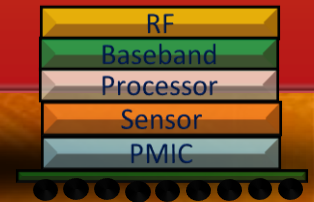
**Market:**  
Mobile, Tablet



**2014**

**Heterogeneous Stacking**

**Market:**  
Mobile, CPU



**2017?**



# Agenda

The Impact of Mobile Era  
Technology Challenges

Economic Realities

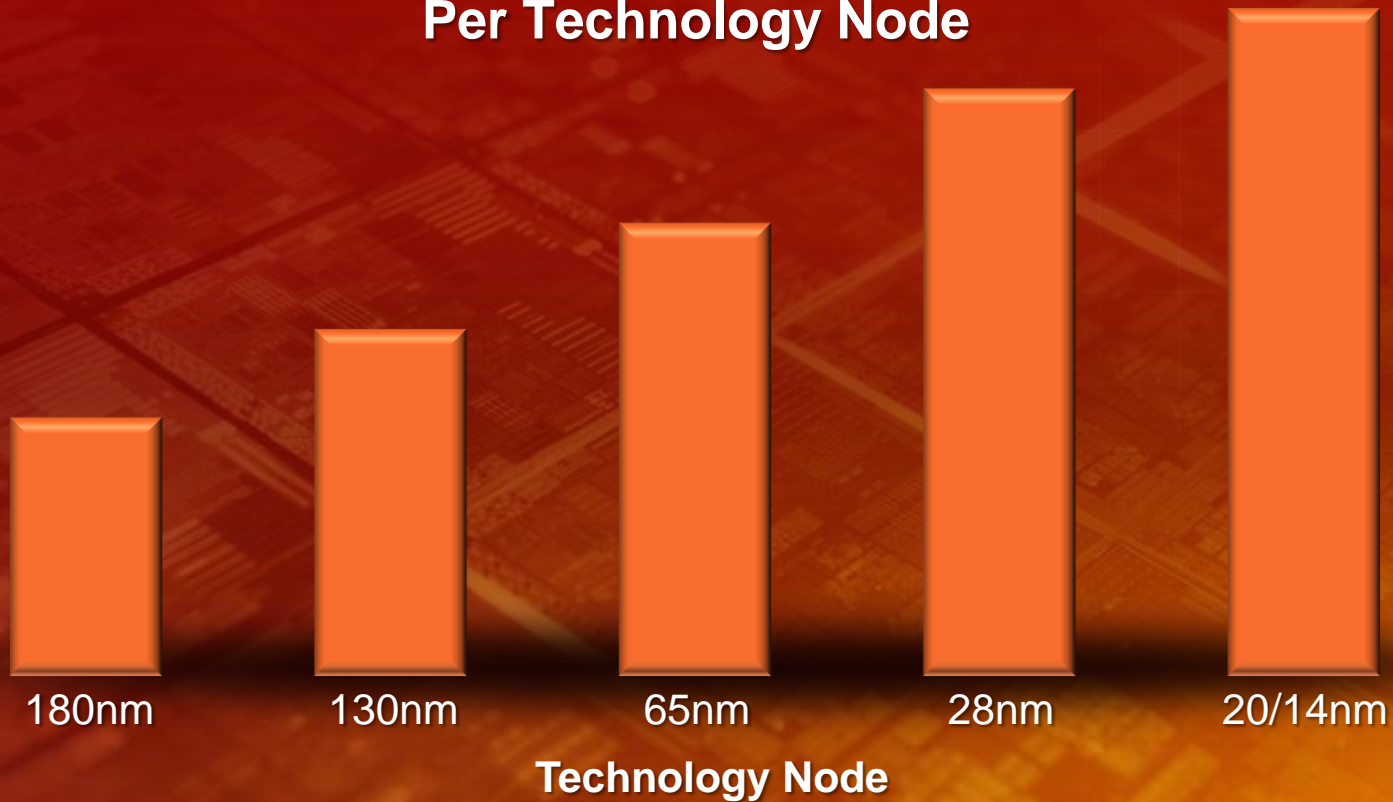
Evolving the Business Model

Foundry 2.0<sup>SM</sup> at Work



# Advanced Technologies Driving Complexity / Cost

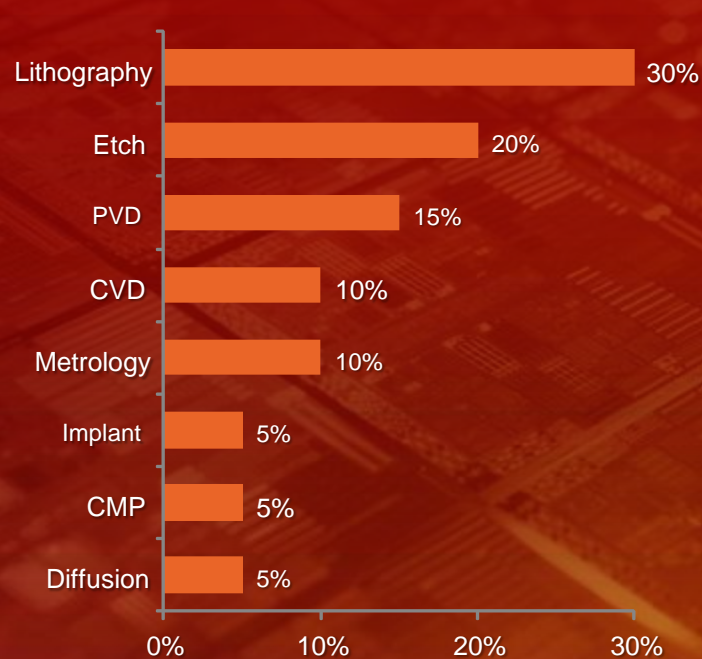
Mask Layer Growth  
Per Technology Node



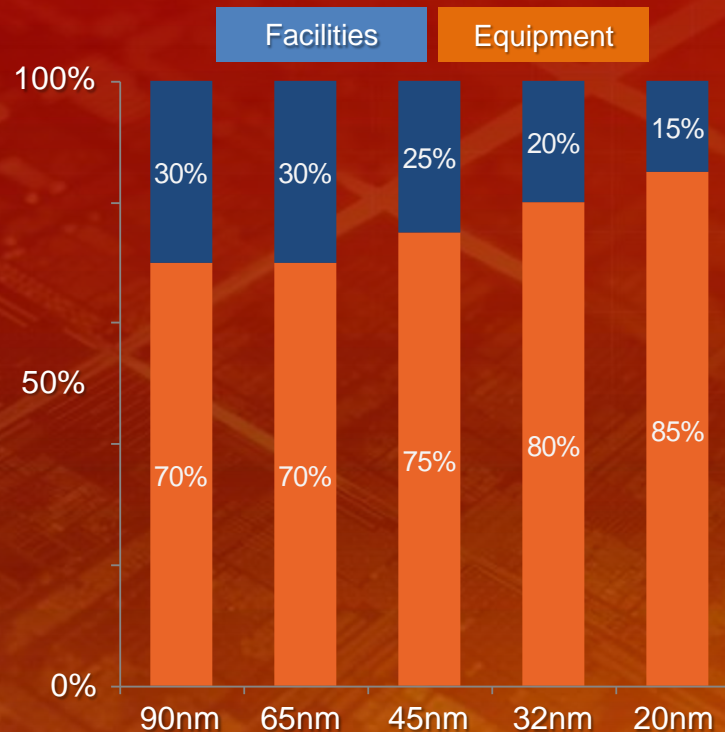


# Technology Complexity Makes Equipment a Greater Proportion of Overall Fab Costs

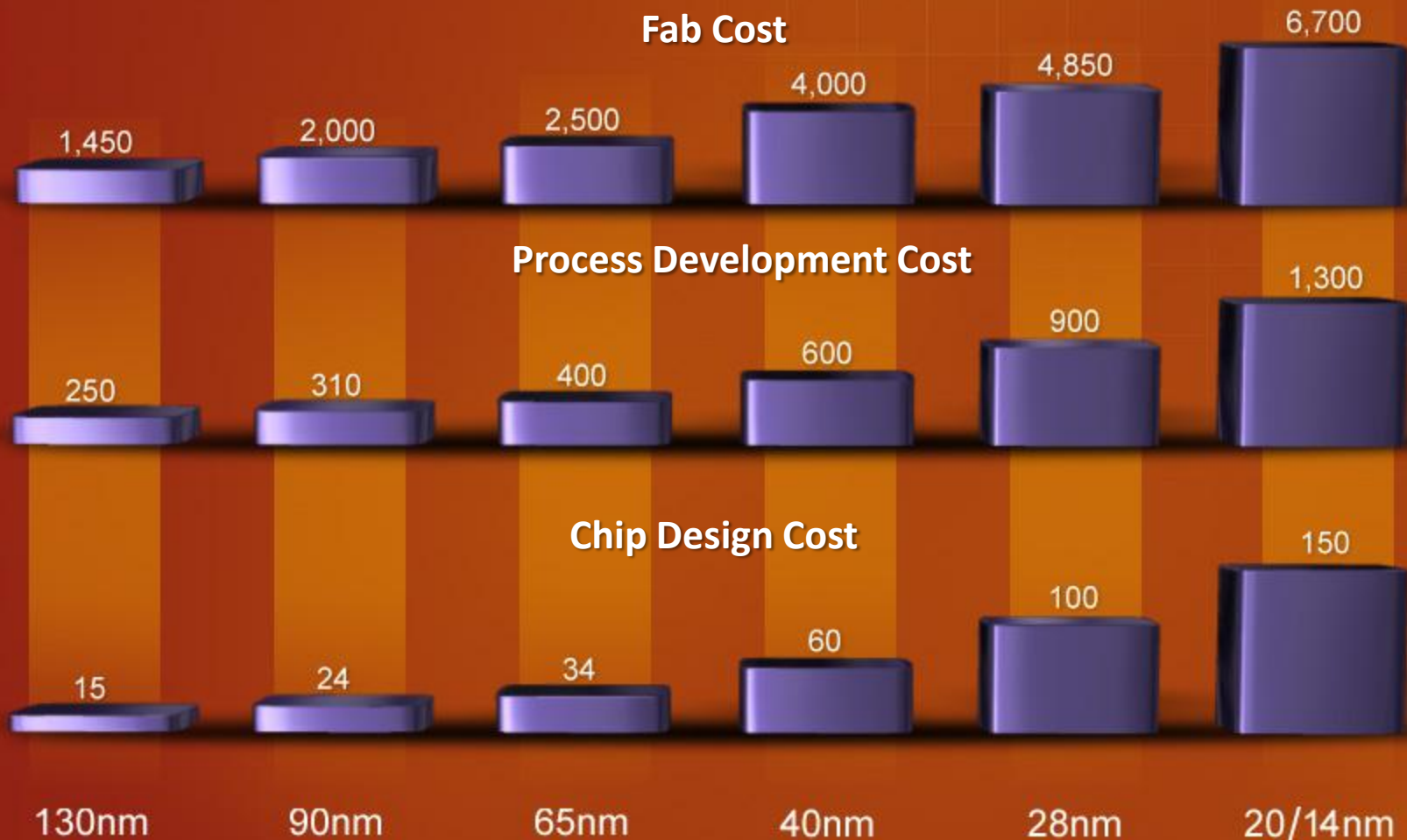
## Breakdown of Equipment Costs



## Historical Breakdown of Fab Costs

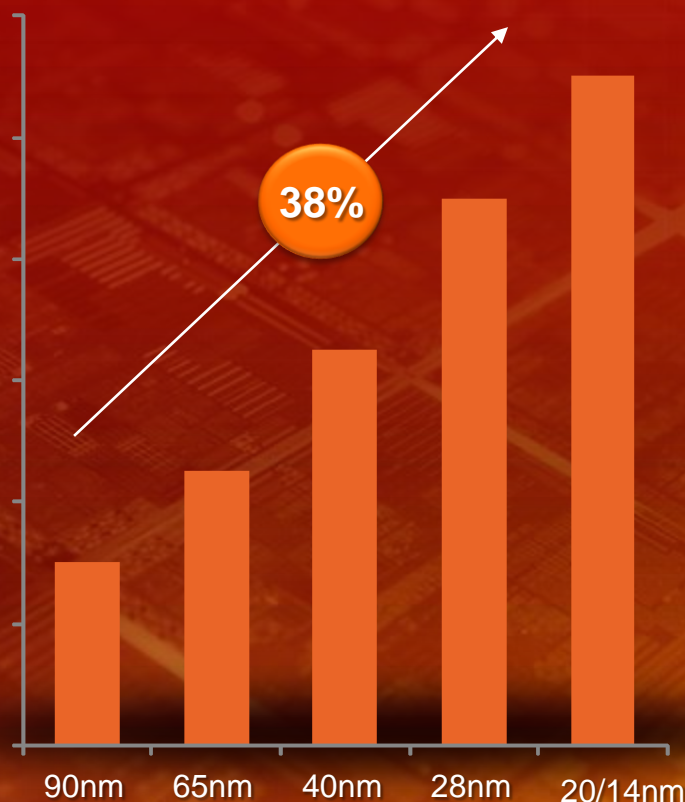


# Advanced Technology Costs are Rapidly Escalating...



# Cost of Building a New Leading Edge Fab is Rapidly Escalating

Capex per k 12" Wafers per Month



**Rising capital costs are increasing investment risk**





# Agenda

The Impact of Mobile Era  
Technology Challenges  
Economic Realities

Evolving the Business Model

Foundry 2.0<sup>SM</sup> at Work



# Evolution of Foundry Model

**1990**

## **Foundry 1.0**

Customer-funded  
contract  
manufacturing  
No transparency  
needed  
Fab cost-savings  
focus

**2000**

## **Foundry 1.0**

Wafer price competition  
Less transparency  
Technology challenges  
Transaction focus  
Zero-sum orientation

**Today**

## **Foundry 2.0<sup>SM</sup>**

Virtual IDM  
Partnering for  
success  
Product/Market  
collaboration  
Time to Everything



GLOBALFOUNDRIES®

Source: VLSI Technology Research

# Why the Traditional Model No Longer Works

Slower rate  
of change

Solutions optimized  
to one product

Systems and methods  
become inflexible

Best solutions rarely  
originate from  
insulated team

**IDM and  
Foundry 1.0  
Model Will  
No Longer  
Work**

Not tapping global  
R&D talent

Lack of flexibility  
and transparency

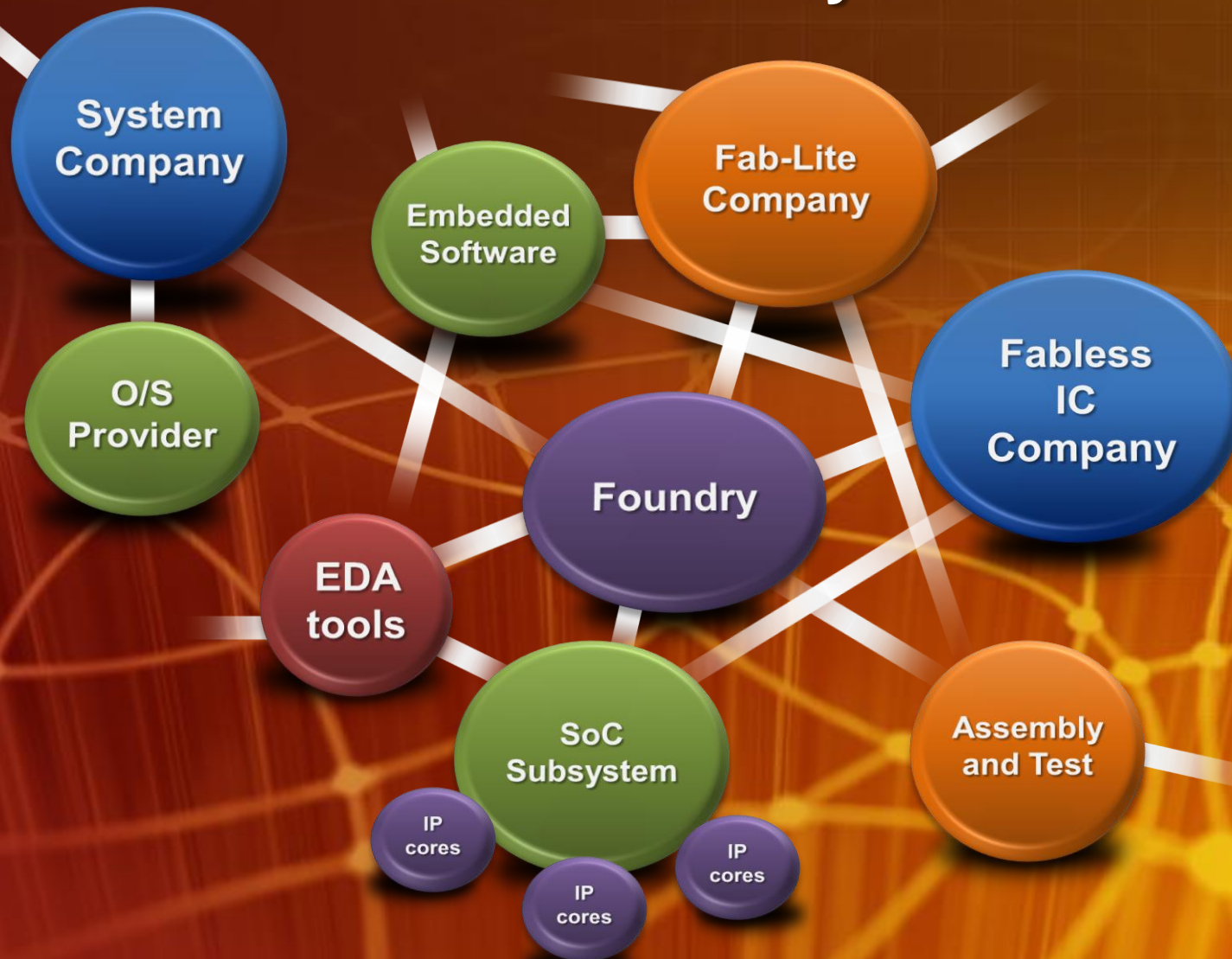
Single source supply  
adding geographical risks

Lack of collaborative  
innovation





# It Takes an Ecosystem



# Rules of the Game Have Changed

Systems Architecture

SoC Architecture

Technology Architecture

SoC Integration

PDK/DFM/EDA

SoC IP

Advanced Devices

Litho/Mask

Manufacturing

Wafer Testing

Packaging/Assembly

Final Test

**Engaging early,  
deeply, openly, and  
comprehensively**

Collaborative Innovation

Tapping global talent

Jointly develop new technologies  
and manufacturing solutions

Focused on  
shared success

*Time to Everything!*



# Agenda

The Impact of Mobile Era

Technology Challenges

Economic Realities

Evolving the Business Model

Foundry 2.0<sup>SM</sup> at Work





# Foundry 2.0@Work: ARM + GLOBALFOUNDRIES

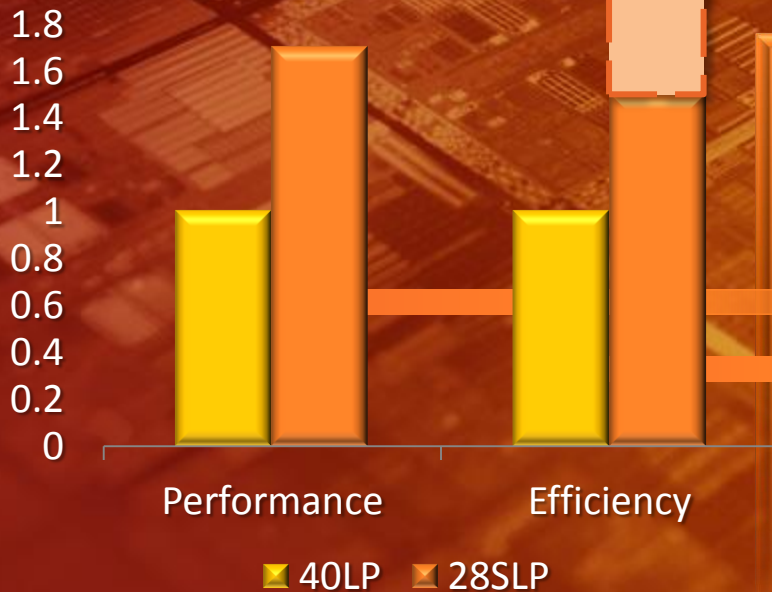
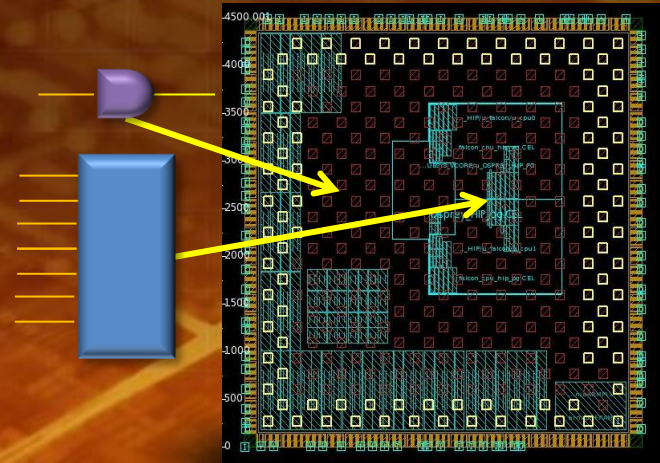
## Cortex-A12 Collaboration

**GLOBALFOUNDRIES** and **ARM** enable early **POP IP** in **28SLP** for **Cortex-A12**

Artisan® Core-optimized Physical IP

ARM Implementation Knowledge

ARM Certified Benchmarking



**ARM's Cortex-A12** architecture, **POP IP** combined with **GLOBALFOUNDRIES 28SLP** process projected to yield significant improvement **over Cortex-A9** in **40LP**:

**1.7X** higher **performance**

**1.5X – 2X** better **power efficiency**

Similar area and leakage.



# Foundry 2.0@Work: Enabling a New Approach to Collaborative Development

*Technology Development Center*



TDC

**\$2B investment in collaborative space to help close the gap between lab and fab**

**Located on Fab 8 campus in Saratoga County, NY**

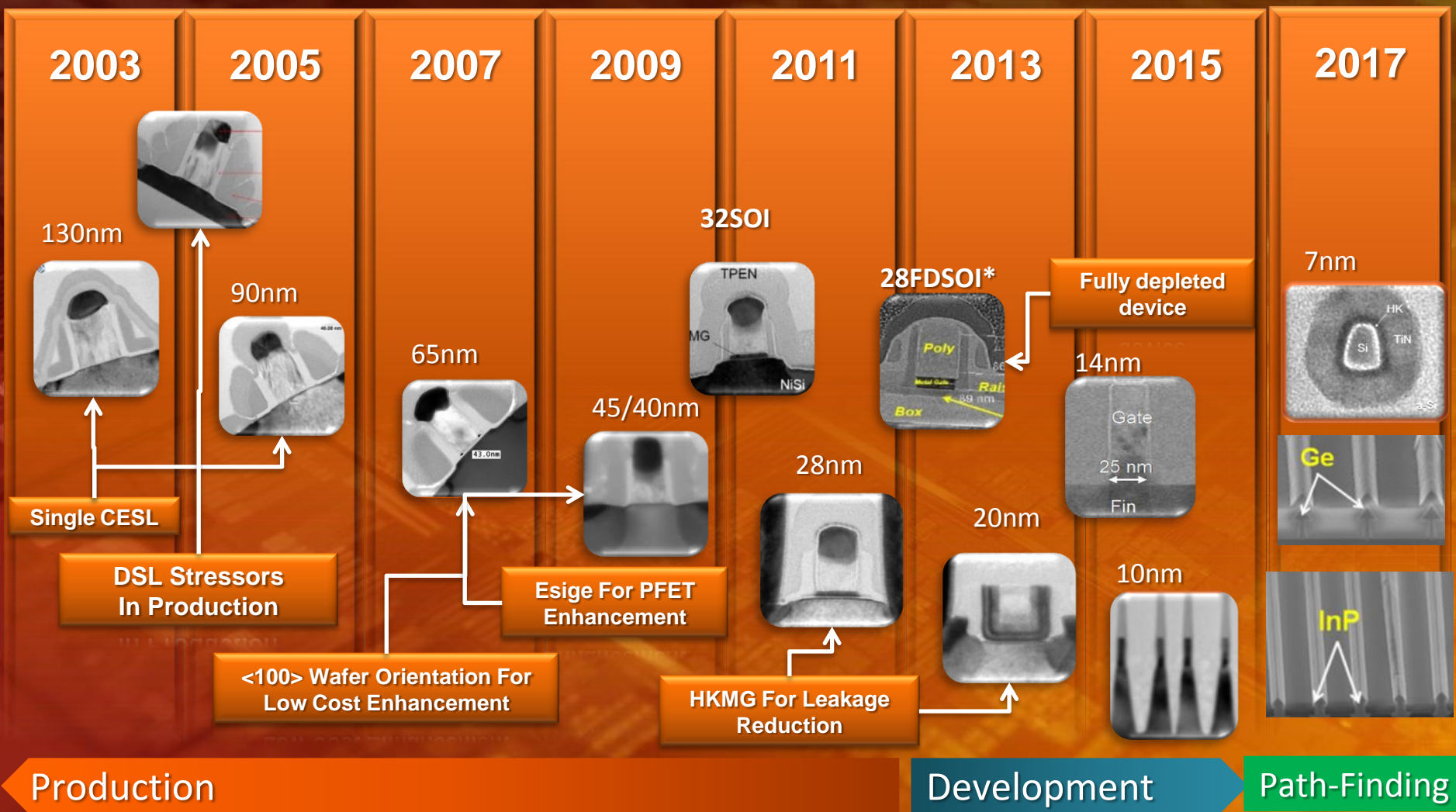
**Strengthens R&D ecosystem from mask to silicon to packaging**



GLOBALFOUNDRIES



# Foundry 2.0@Work: Pushing the Leading-Edge... And Accelerating the Process Roadmap



\* In collaboration with ST

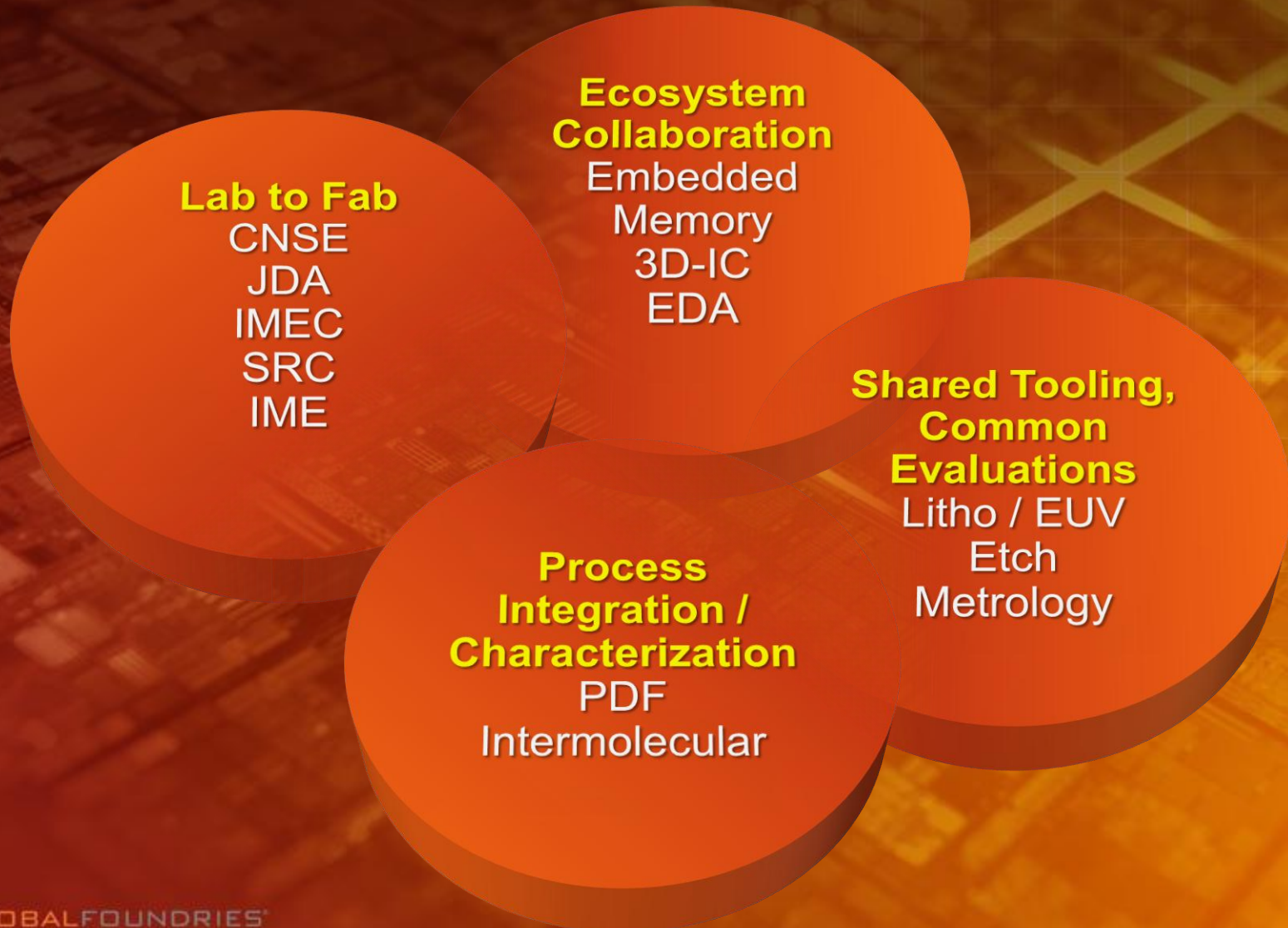


GLOBALFOUNDRIES®



# Foundry 2.0@Work: 10nm Development Model

## The Future Today...Enabled by Collaboration



# Foundry 2.0@Work: Leading-Edge SoCs

Rockchip's RK3188 and RK3168 next generation mobile processors

China's 1st 28nm HKMG  
Multicore tablet SoCs in  
production

Delivers high performance  
AND low power

ARM Cortex-9 based



Manufactured exclusively by  
GLOBALFOUNDRIES

Early close collaboration  
between design and  
process technology teams

1.8 GHz performance  
and ultra-low leakage  
28SLP HKMG process

*"This partnership is a true demonstration of GLOBALFOUNDRIES' unique approach to Collaborative Device Manufacturing. Rockchip is fortunate to have a partner like GLOBALFOUNDRIES."*

Chen Feng, Rockchip Executive



# Addressing Technology, Talent and Economic Challenges...Were you correct?

Supply Chain  
Challenges

Open Fab Concept /  
Collaboration

Operational  
Excellence

IP Security

Supply  
Continuity / Global  
Footprint

Technology and  
Innovation Leadership



**FOUNDRY 2.0**

Fully Optimized  
for Mobile Era

*Time to Everything!*



GLOBALFOUNDRIES®



# Join the Elite on Today's Playing Field

Device Architecture /  
Materials

450mm

**FOUNDRY 2.0**  
*Time to  
Everything!*

Litho / EUV

Advanced Packaging

*Challenge your teams to play in the big leagues of Foundry 2.0*



GLOBALFOUNDRIES®



GLOBALFOUNDRIES®